MODIFIED RESPONSES TO QUESTIONS SUBMITTED AT GEOTHERMAL RESOURCES SEMINARS

OCTOBER 23 & 24, 1984 - OAHU
OCTOBER 24, 1984 - HILO
OCTOBER 25, 1984 - MAUI

Question 1:

"It is my understanding that considerable variability exists between the gaseous emissions from one geothermal well to another. How do the emissions from the geothermal wells in Rotorua compare in their chemical quality and quantity with the HGP-A well?"
(Siegel, Thomas)

Response:

Considerable variability does exist between the emissions from different geothermal wells. The chemical "signatures" of different geothermal systems are often like fingerprints, assuming that different reservoirs are being compared. In Rotorua, however, the principle sources of emissions are widely dispersed fissures, cracks and fracture areas plus permeation up through perhaps 25-30 percent of the lake floor itself. All of these release points are natural, not man-developed (anthropogenic) wells. They can best be compared with the Sulfur Bank fumaroles.

The Sulfur Bank emissions contain hydrogen sulfide (H_2S), sulphur dioxide (SO_2), sulfur vapor (S-vapor), mercury vapor (Hg-vapor), mercuric chloride ($HgCl_2$), large amounts of carbon dioxide (CO_2), small amounts of carbon monoxide (CO), small amounts of hydrogen fluoride (HF), and small amounts of selenium (Se) condensed with the sulfur (less than 1 part of selenium per 1000 of sulfur). Open air H_2S and SO_2 levels at the Sulfur Bank fumaroles commonly exceed 1000 ppb and can reach 10,000 ppb of either or both on occasion. Total air mercury there has exceeded 15 micrograms per cubic meter, but has recently fallen at least 10-fold.

In Rotorua, SO_2 does not reach 1.0 ppb whereas H_2S readily reaches 50 or 100 or 400 ppb at the same location. We have no data of our own on CO_2 or CO, but CO_2 is prominent. Mercury levels, though variable, are well under 0.5 micrograms per cubic meter, though they are much higher in volcanic hot spots. Rotorua air contains no traces of arsenic or fluorine.

At HGP-A, before installation of the turbine, the plume itself measured at wellhead gave values of 3000-4000 ppb H_2S but a few hundred meters downwind it has rarely exceeded 10 ppb. Initially mercury around HGP-A (within 10-100 m of the wellhead) measured about 1.0 micrograms per cubic meter. Currently, it is below our limit of detection at 0.03-0.05 micrograms per cubic meter.

In summary:

	H_2S	SO_2	CO_2	Mercury
HGPA	+	–	+	trace
Sulfur Bank	+++	++	+	+
Rotorua	+++	–	+	+
Kilauea*	-to tr	+++	+	+

*at Halemaumau

$\underline{H_2S}$

+	=	normally < 10 ppb
++	=	normally 10-100 ppb
+++	=	normally > 100 ppb
tr	=	detection limit = 5 ppb
-	=	< 5 ppb

$\underline{SO_2}$

+	=	normally < 30 ppb
++	=	normally 30-1000 ppb
+++	=	> 1000 ppb
tr	=	detection limit 15 ppb
-	=	< 15 ppb

$\underline{Co_2}$

(ambient air level = 330 = 340 ppm)

+ 2x or more of ambient

Mercury

trace	=	$\leq$ .050 g
+		> .050 g

There are many privately owned wells in Rotorua and no definitive listing of their emissions is available. However, the high concentrations of hydrogen sulfide measured in the ambient air (up to 1500 parts per billion) is largely a result of natural geothermal process not man induced.

Question 2:

"Two years ago a columnist with the Hawaii Tribune Herald made the statement that "The lack of trust in government to be a good regulator is a major factor in the anxiety among residents near potential well areas." Do you concur with this statement and if so what steps can you recommend to address the problem? (Miller, O'Brien, Parnell, Siegel)

Response:

We strongly concur that lack of trust or respect for governmental regulators is a major factor in promoting community concern among residents near potential well areas. The recent experiences with pesticide contamination of the drinking waters has only served to augment these concerns. Certainly as a governing policy the State government must be concerned with the health, safety and welfare of people living in geothermal development areas. Address of this concern is evidenced by the numerous studies funded by the State to examine the environmental issues associated with geothermal developments. In meeting its additional responsibility to promote continued economic growth and expansion of the labor force the state must balance the need to maintain infrastructure services against environmental costs. The need for balance in both environmental protection as well as development scenarios is essential.

One of the best methods by which environmental concerns can be given the maximum yet fair attention that they deserve is to incorporate specific permit conditions into contracts let for development of geothermal wells or related infrastructure facilities.

It may also be possible to negotiate separate legal agreements with the developer to assure the community of his intention to comply with permit conditions.

Question 3:

"What federal and state emission standards are in effect for geothermal emissions?" (Anderson, Parnell)

Response:

Currently, there are no federal and few State ambient air standards in effect for hydrogen sulfide (H_2S). The State Department of Health is promulgating regulations to control emissions from geothermal sources, and establish an ambient air standard for H_2S. DOH intends to adopt State emission standards (DOH Administrative Rules, Title 11, Chapter 60). Hearings on this are scheduled for early 1986. Other potential geothermal emissions are covered by both EPA and State standards, just like any other power plant. The following table provides the H_2S emission standards for some of the other states (Yerino, L.V.: G. Annamraju; W.E. Kemner; 1981). While the standards are not specifically for geothermal H_2S, the actual source of H_2S is not significant.

TABLE II. SPECIFIC STATE H_2S EMISSION STANDARDS

State	Ambient air standards
California	0.03 ppm (1-h average)
Delaware	0.06 ppm (30-min average) 0.03 ppm (60-min average)
Kentucky	0.01 ppm (1-h average)
Minnesota	0.05 ppm (30-min average; not to be exceeded more than twice per year) 0.03 ppm (30-min average; not to be exceeded more than twice in 5 consecutive days)
Missouri	0.03 ppm (1/2-h average; not to be exceeded twice in 5 consecutive days) 0.05 ppm (1/2 h average; not to be exceeded more than twice per year)
Montana	0.03 ppm (1/2-h average; not to be exceeded more than twice in 5 consecutive days) 0.05 ppm (1/2-h average; not be exceeded more than twice per year)
New Mexico	0.003 ppm (1-h average for the State) 0.01 ppm (30-min average for PECOS-Permian Basin Intersate)
New York	0.01 ppm
North Dakota	0.032 ppm (30-min maximum; not to be exceeded more than twice in 4 consecutive days) 0.054 ppm (30-min maximum; not to be exceeded more than twice per year)
Pennsylvania	0.10 ppm (1-h average) 0.005 ppm (24-h average)
Texas	0.08 ppm (30-min average)
Wyoming	70 $\mu g/m^3$ (0.05 ppm) (30-min average; not to be exceeded more than twice per year) 40 $\mu g/m^3$ (0.03 ppm) (30-min average; not to be exceeded more than twice in 4 consecutive days)

Question 4:

"What is the probable dollar cost of permitting and the EIS for the Ulupalakua, Maui geothermal project assuming 4 wells and 1 power plant?"
(Munger, O'Brien, Parnell, Thomas)

Response:

We do not have a total cost figure. The amount of $91,225 has been comitted by Maui Electric Company, True/Mid-Pacific Geothermal Venture and DPED for an ongoing environmental monitoring program at Ulupalakua, Maui. The cost of an EIS will vary considerably. An order of magnitude estimate which includes time at public hearings, permit preparation, EIS preparation, responses to comments etc. could range from $100,000 to $500,000. If court actions are involved, the EIS and permitting costs could exceed $1 million. The Puna Geothermal Venture has invested $10 million, for exploration.

Question 5:

"The designation of a Geothermal Resource Subzone has as one criteria that it's development will have 'minimal' social and environmental impact. How can that be assessed without doing an EIS?" (Lamoureux, O'Brien, Parnell)

Response:

Act 296 which required the subzoning, specifically stated that, "an EIS shall not be required for the assessment of areas under this section (205)". That same act said that the Board of Land and Natural Resources (BLNR) will examine the various factors as part of the assessment process. A consultant, Environmental Capital Managers, Inc., did perform a "Social Impact Analysis of Potential Geothermal Resource Areas" and BLNR did an Environmental Impact Analysis of Potential Geothermal Resource Areas."

The assessment of the social and environmental impact may be done without an additional special EIS for the subzone designation if an adequate recent EIS has been prepared for the area including the subzone as part of an earlier process leading up to the subzone designation.

Since the designation of a Geothermal Resource Subzone is just a land use designation, an environmental assessment was felt to be sufficient. It would be hard to prepare a formal EIS when there is no specific project under consideration, i.e., size and location of the development. The designation only allows the activity to be requested and conveys no rights. Additional environmental assessments will be needed for drilling permits, and probably a full EIS for a power plant.

Question 6:

"According to the EIS C-106 10/84, the maximum allowable concentrations (for those substances for which limits have been set - as they have not eg. for Mercury, Radon, C - gas) are permitted to be exceeded once in a 12-month period. It seems that this is not specific and is poor a safeguard. Please respond." (Miller, Thomas)

Response:

Our reviewers were not familiar with the EIS reference you cited, however, we would like to stress that limitations on any emission of concern can be imposed as a permit condition at the time a specific proposal is made. Standard regulatory procedures should be followed in any regulation of the geothermal industry.

Question 7:

"What is the H_2S emission standard (ppm in air) for Geothermal in California? What can we expect it to be in Hawaii?" (Anderson, Houck, Siegel, Thomas)

Response:

California has adopted an ambient air standard for H_2S at 0.03 ppm (30 ppb), averaged over a one-hour period and a total emission limit of 50 grams/megawatt hour. Originally, the ambient air standard was based on odor detection levels. Studies have subsequently shown the median threshold for odor detection is considerably lower. In fact, the median threshold value for odor detection (but not necessarily substance recognition) is currently accepted to be 0.005 ppm.

Although the State of Hawaii has not adopted an ambient air standard for H_2S, proposed revisions to Admisnistrative Rule Chapter 11-59 (Hawaii) as of June 12, 1984 called for a standard of 139 ug/m^3 averaged over one hour which is equivalent to 100 ppb (volume) at 25° C (77° F) and 760 mm (29.9 in) Hg pressure. This standard should protect residents from adverse physiologic health effects. The proposed rules also included a provision for an increment concentration of 35 gc/m^3 (25 ppb) averaged over 1 hour. This increment would be the limit on H_2S contributed by all man made sources. It represents the amount of additional H_2S allowable over and above naturally occurring concentrations. The sum of the increment plus the natural background H_2S should not exceed the ambient standard of 139 g/m^3 (100 ppb).

Yet another regulatory figure for geothermal development has been briefly discussed by the Department of Health and that refers to a total emission limit of 5 percent or less of the total H_2S present in the geothermal fluid.

Question 8:

"What is the odor threshold of H_2S in air?" Is it affected by temperature or humidity? (Anderson, Houck)

Response:

H_2S has a characteristic "rotten egg" odor detectable at levels far below those at which the first well-documented physiologic health effects (e.g. conjunctivitis) have been reported. The median threshold level for odor perception is 0.005 ppm, although odor detection thresholds reportedly vary from 0.0005 to 0.03 ppm and higher in the literature. These values are determined under conditions of exposure to pure dry air where no other potentially masking odors are present. At .005 ppm H_2S may be detected but recognition of the odor as H_2S may require values higher than this level. There is no specific value which can be given to the odor threshold for H_2S since it varies from person to person. One study tested 789 individuals at fairs in Washington, Oregon and Idaho. The mean threshold value was 6.44 ppb (.0064 ppm) (volume).

It is very likely that H_2S odor perception does vary with temperature and/or humidity, as most odors do. However, the effect of temperature and/or humidity on odor perception has not been well studied for H_2S per se.

One of our panelists (Houck) came across the following compilation of odor perception limits for H_2S (Yerino, L.V., G. Annamraju; W.E. Kemner; 1981). While the values were not specific to geothermal emissions, the pollutant, H_2S, is the same regardless of its origin so these odor perception limits are a good example of what might be expected in Hawaii.

TABLE I. ODOR PERCEPTION LIMITS OF H_2S

Source	Result	Concentration, ppm
1. Experiments of the *Bryce Thomson Institute	Odor detectable	0.025
	Distinct odor	0.30
	Offensive odor	3-5.0
2. Literature	Odor threshold	0.025
	Odor weakly noticeable	0.1
	Odor clearly noticeable	0.3
	Strong odor	20-30
3. Tests at F. E. Erisman, Scientific Research Sanitary Institute	Odor not perceptible	0.0014 to 0.007
	Sensed by olfactory organs	0.007
	Slight odor	0.007 to 0.35
	Odor definite and clearly perceptible	0.042 to 0.014
4. Study with humans	Olfactory threshold	0.007 to 0.02
	Affects light sensitivity of eye	0.006
5. Study with humans	Olfactory threshold	0.026
6. German Technical Committee	Olfactory threshold	0.025
	Slight perception	0.1
	Odor definitely perceptible	0.3
	Odor perceptible but not intolerable	20 to 30
7. NIOSH study	Odor threshold	0.0081
	Other reported values	0.13
		0.791
8. ADL study	Odor threshold	0.00047

*Boyce Thomson Institute

Question 9:

"What other pollutants beside H_2S are of biological concern (in Hawaii)?"
(Houck, Munger, Siegel, Thomas)

Response:

With regard to the Kilauea Rift Zone where there are both volcanic emissions and potentially future geothermal emissions the list would be: hydrogen sulfide (H_2S) and sulphur dioxide (SO_2), particles (the chemical composition of particles is important), radon and mercury vapor. The elements of arsenic (As), boron (B), selenium (Se), mercury (Hg) and other heavy metals in particles and rain water are also of concern.

The Kilauea main vent at Halemaumau, produces in one year, without eruption, about 40,000 tons of SO_2 and 100 tons of mercury plus enough sulfuric acid (formed from sulfur trioxide (SO_3) and water) to give rainfall pH values as low as 3.0-3.5 at the Volcano Golf Course. During eruptions SO_2, radon and mercury output can rise 10 to more than 100 times and acid rains can affect the tomato crop in Kona.

In Honolulu, along areas of high peak traffic density or in confined spaces, e.g. lower parking areas at Ala Moana, the State Capitol, or in the Pali tunnels, high levels of exhaust pollutants may occur. Lead emissions are greatly reduced from their 1970 level of about 400,000 lbs annually in Honolulu. Recent American Lung Association figures suggest only 100,000 lbs annually.

The question of "Biological Concern" should be restated to: "Relative Potential Concern". On a scale of 10, with the higher values indicative of increased concern, our consultants suggest:

9-10	N-oxides, methylmercury
7-8	SO_2 on carbon or sulfate particularly
6	SO_3 and SO_2, mercury, arsenic
4-5	Carbon monoxide, lead, chlorine, ammonia
2-3	Hydrocarbons
1	Hydrogen sulfide

This is only a rough scale, and many variations will be encountered, but it conveys the idea that H_2S is not the major concern as a toxicant from the health standpoint.

We should stress, however, that no other pollutants have been found in Hawaii's geothermal resource that indicate a hazard to biota as long as standard geothermal industry practices are followed. However, fluids from each new geothermal well should be analyzed to ensure that emissions from a power plant will not cause problems.

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Question 10:

"Did your health survey (Puna area) account for ethnic differences in populations?" (Anderson)

Response:

Statistically significant ($p < .05$ by Chi-square analysis) differences in ethnic make-up were found between Leilani Estates, the "exposed" community, and the control community in Hawaiian Beaches. There were also differences in several other demographic variables that are important to consider when comparing disease prevalence; these include population movement, length of stay in Hawaii, education and income levels. Rates of the various health conditions for which comparisons are made were standardized only for differences in age distribution. Thus, there was no direct accounting for ethnic differences in the analysis.

Question 11:

"Did your health survey (New Zealand) account for ethnic differences in populations?" (Siegel)

Response:

The data provided, by the Research Officer in the Ministry of Health's Centre for Health statistics varies. Some are raw mortality, but others are calculated as standardized mortality ratios, compensating for differences in population, age and ethnic structure.

This is an important question, because, sadly, the state of Maori health is very poor compared with Caucasians. This is only partly genetic—Polynesians are more prone to diseases of the respiratory tract (authority: Clifford Straehley, M.D., thoracic surgeon and pulmonary expert, Kaiser Hospital). According to the World Health Organization, Maoris have high rates of lung cancer—Maori women the highest on Earth. Such figures apply to populations far removed from geothermal areas.

The good health picture in Rotorua is therefore especially important as the Maori make up about 25% of the local population, well above national average (ca 15%). Maori of the Arawa Confederation have lived on the steamy, smelly shores of Lake Rotorua as a matter of free choice for 600 years.

Question 12:

"You found no correlation between H_2S and respiratory ailments. You also found no data to vindicate H_2S. Is that correct?" (Anderson, Siegel)

Response:

In Puna, Anderson could find no evidence that residents exposed to low levels of H_2S in Puna were experiencing an unusual amount of chronic respiratory disease when compared to controls in Puna. On the other hand, we could not demonstrate conclusively that this exposure is without consequence. Indeed, apart from adverse physiologic effects, there are possible psychological and social impacts to consider that may be associated with the malordorous quality of H_2S that were not explored or addressed in the health survey. It would be practically impossible to prove H_2S has absolutely no health effects, especially if one considers psychological or social effects in the definition of health.

Preliminary results of studies by Siegel appear to indicate no correlation between natural levels of H_2S experienced in Rotorua New Zealand on a daily basis and various respiratory diseases reported.

Question 13:

"What is the expected cost of energy from the Ulupalakua geothermal development and how does it compare to conventional and other alternative energy sources? What major factors could make energy cost go up?" (Munger, O'Brien)

Response:

The cost of geothermal energy would be based on the "avoided cost" as defined by the PUC and would not be greater than conventional or other alternative sources. Any price escalation would follow the normal inflation rate and would not be subject to the possible artificial price increases of oil. If a geothermal resource is available on Maui it would assure energy availability which may not be true of imported oil.

The costs to consumers of geothermal power will be the same as for conventional sources due to "avoided cost" requirements. Protracted permitting efforts, facility losses due to eruptions, or dry wells are some of the factors that influence the "true costs" of geothermal energy.

Question 14:

"To what extent has hydroelectric potential been studied on Maui?" (Munger, O'Brien)

Response:

The State Department of Planning and Economic Development participated with the County of Maui in a hydro electric feasibility study for the East and West Wailuaiki Streams. Other possible sites considered were Waihee River and Hanawi Stream.

There is the potential for developing hydroelectric capabilities on Maui and this has been studied by the State and is currently under study by the county of Maui. Capital costs are relatively low for hydroelectric power and there are no fuel costs, but the capacity factor (i.e., percent of time that the system is actually producing electricity) is low in Hawaii.

Question 15:

"What has been the environmental impact analysis of deepwater cables — potential problems or hazards?" (Munger, O'Brien)

Response:

We have a preliminary environmental analysis which identifies the following areas of concern: Unique or native ecosystems, wildlife (whales, fishery, and precious corals), noise, archaeological/historical resources, land use, public health and safety, aesthetics, field effects, air quality, employment and population growth. The report, Environmental Analysis for Phase II-A of the Hawaii Deep Water Cable Program, prepared by Parsons Hawaii, March 1984, is available from DPED.

Question 16:

"If a power cable is planned from Hawaii's geothermal development to a market on Oahu with 500 mw, why develop geothermal on Maui, tap the Big Island instead." (Munger, O'Brien)

Response:

Geothermal development on Maui is needed to satisfy and assure the availability of the present and predicted increase in electrical demand on Maui. Presently only the Big Island is expected to produce the electrical energy required to help satisfy Oahu's needs.

Question 17:

"What, if any, air flow and wind current studies have been undertaken in the Ulupalakua/ Makena area. They are complex there, both horizontally and vertically and should be understood as a part of the environmental assessment." (Munger)

Response:

The baseline monitoring currently in progress at Ulupalakua will provide a meteorological data base for initial assessments of air quality impacts of proposed geothermal development.

Question 18:

"Did you need 3 trips to get that information (New Zealand Study)?" (Siegel)

Response:

It may require 5 or 6 trips to New Zealand in order to compile sufficient data to objectively and quantitatively determine what, if any, relationships exist between health and geothermal emissions in New Zealand. There are multilevel considerations: first, health data from another sovereign state for use in Hawaii cannot generally be released by mail. The first three trips involved (a) identifying, (b) contacting and (c) collaborative data search. In any study where an "outside" investigator requires the cooperation of an agency or organization, it is essential to establish oneself as a professional colleague and the project as credible and useful so as to assure maximum cooperation of the host country, agency, or organization. Second, a comparison of Janaury (New Zealand summer) and July (New Zealand winter) H_2S data indicates that there is tremendous seasonal variation. We do not have sufficient data, however, for correlation studies and will need intermediate calendar points such as March and September. In order to do a really thorough job we will require about 2 more years, more money and more repeat measurements on repeat visits.

Question 19:

"Did you survey for headaches (Puna Survey)? What percentage had nothing to say? What was the percentage of colds in Leilani Estates?" (Anderson)

Response:

None (0) of the residents interviewed in Leilani Estates reported chronic headaches or migraine during the year prior to the interview (January 1983 - Janaury 1984). However, 10 (1.7%) of 603 residents surveyed in Hawaiian Beaches reported at least one of these conditions during this period.

Interviews were administered in 135 (88.8%) of the 152 households in Leilani Estates, representing a total of 350 individuals in the area. Those not surveyed either refused or were away on extended trips and could not be contacted within the survey period. Of those who were contacted, it could not be determined from the information collected who, if anyone, had "nothing to say."

Altogether, 54 (14.3%) of the 350 residents in Leilani Estates surveyed reported the "common cold" during the month of January, 1984. This was the most frequently reported acute condition in Leilani Estates.

Question 20:

"How much does the State get for its permits and percentage leases?" (O'Brien)

Response:

The Board of Land and Natural Resources determines the rate which shall not be less than 10% nor more than 20% of gross amounts or value of geothermal resources produced as measured at the wellhead and sold.

Question 21:

"What are you doing to persuade the P.U.C. to lower the cost of energy to the consumer?" (O'Brien)

Response:

The State Consumer Advocate represents the consumer's interests before the PUC. The State Department of Planning and Economic Development is promoting the commercialization of alternate energy technologies to reduce Hawaii's dependence on oil, and therefore Hawaii's vulnerability to probable future oil price increases.

Question 22:

"If cheaper power is available, shouldn't the savings be passed on to the consumer? Why 60% reduction in solar budget for research?" (O'Brien)

Response:

Alternate energy technologies may not provide lower cost energy at the present and projected near-term cost of oil. However, when more fully developed they will provide energy availability and could provide a hedge against escalating oil prices and increased energy costs to the consumer. There has been a drastic reduction in the U.S. Department of Energy's funding of solar projects. The State has maintained about the same level of funding.

One must keep in mind that the availability of oil cannot be considered a permanent option. Given the whims and avarice of the political systems upon whom we presently depend for our fuel oil supply, the examination of alternate energy technologies, including geothermal, is a reasonable and responsible task.

Question 23:

"Are you proposing that we will benefit by contaminating our clean air of Ulupalakua with the fumes of hydrogen sulfide? Why should we inflict this upon ourselves simply because other peoples of the world?" (Siegel)

Response:

No, we certainly do not suggest that contaminating clean air in Ulupalakua will be of benefit to Maui residents. Clean air in Ulupalakua or anywhere else in Hawaii should be protected by implementing technology appropriate to the concern. As we mentioned in response to earlier questions regarding air quality and emission standards for geothermal development, emissions from a geothermal power plant can be controlled similar to any other power plant. Standard regulatory procedures will be followed and specific permit conditions can be imposed to limit or restrict noxious emissions once the location and type of development being proposed are known. The people of Maui will not be afflicted with excessive fumes of hydrogen sulfide. A great deal has been learned about controlling emisisons, if it should come to development of a Maui resource.

Question 24:

"The designated area for development in Ulupalakua is quite large. If drilling is successful, could not the entire designated area eventually be covered with wells?" (Munger, Thomas, Parnell)

Response:

It is unlikely that the geothermal resource will be extensive enough to cover the entire area. Also, certain property owners, including Ulupalakua Ranch, within the geothermal subzone, do not want all of their land developed for geothermal energy or have planned other uses for it.

There is no demand for that much power. At this stage we don't know whether an economic resource is present. The temperatures may be too low for it to be economically viable to even develop one well. They have to drill to find out.

Any development in the Ulupalakua area will have to undergo further permitting review at each step of the development process. If the development will produce substantial impacts on the surrounding areas, further development can be halted.

Question 25:

"In the past 2 years, there have been hundreds and hundreds of acres of ohia wood and ferns that have been bulldozed in the Kamaili, Opihikao, Pohoiki and Kalapana areas. These lands are owned by the State. Why is the State allowing this? This must be stopped immediately." (Lamoureux, Miller, O'Brien)

Response:

The Forestry and Wildlife Division Administrator, Libert Landgraf, has stated that there has been no on-going logging or clearing operations on State land in these areas. If you have information to the contrary, we would appreciate your bringing the specifics to our attention (Environmental Center, University of Hawaii) and we will look into the matter.

Question 26:

"What, if any, effect will the proposed 2,000 feet setback for Kahauale'a subzone have on endangered species?" (Lamoureux)

Response:

The proposed 2000 foot setback for the Kahauale'a subzone will probably have little effect on the Park/Kahauale'a boundary since much of the area is covered by recent lava. On the Wao Kele o Puna/Kahauale'a boundary there is a strip of high-quality native forest in those parts of the setback not covered by the 1983-84 Pu'u O eruptions.

Question 27:

"What, if any, baseline study has been conducted of rainwater (catchment) in Puna?" (Houck, Siegel, Thomas)

Response:

In April 1977, the Hawaii District Health Office in Hilo conducted a study at the request of the Hawaii County after the latter was told that dangerous emissions and toxicants were being introduced into the water catchments. The then houses of Hughes and Rothblum families SW of HGP-A, of the Kuberas WSW, of the Reichs ENE of HGP-A and of the Daniels' over 8 km ENE were tested. At the time mainly light variable trades had been blowing for about 5 days. No H_2S, fluoride, sulfate, nitrate, arsenic or mercury were detected at any location except for one trace of nitrogen, possibly from a passing bird. SO_2 was present in all catchments but was as high at the remote Daniels' residence as it was close to HGP-A.

No samples were taken from any catchment water systems directly during either the DPED or True/Mid-Pacific Geothermal Venture Baseline studies. However, between the period of January 1983 through March 1985 about 57 rainfall samples have been collected in ultra-clean containers and analyzed. Several (5 or 6) water systems near HGP-A were sampled by Don Thomas over a 3-year period while HGP-A was in operation. No impacts whatsoever, to the water systems, could be attributed to HGP-A or other geothermal sources.

Question 28:

"Your environmental assessment group measured the level of hydrogen sulfide gas in the raw geothermal steam at the HGP-A to be only 3.1 parts per million, while Dr. Don Thomas testified that this level is now 900-1,000 parts per million, which is one thousand times more concentrated than the raw steam in Rotorua, New Zealand. Did you make an error in your original estimation or has the level of hydrogen sulfide gas increased by 300 times?" (Siegel, Thomas)

Response:

The steam, as a gas at normal atmospheric pressure, after release to the atmosphere contains about 3.1 ppm H_2S. The 3.1 ppm level was measured in the steam plume down wind of the emission point, i.e., in the atmosphere. This was the value reported by Sanford Siegel. The 900 -1000 ppm level was measured in the pure steam inside the pipes of the power plant. The concentrations in Rotorua steam are highly variable and are certainly present at concentrations of more than 1 ppm.

In contrast, Don Thomas reported a "Downhole" concentration of H_2S in a liquid composed of super heated but highly compressed steam in hot water, above normal boiling point, under pressure. Without expansion and air dilution, the contained geothermal fluid analyzes H_2S of about 1000 ppm. In other words, expansion and air admixture dilute the H_2S content about 300-fold. In the open hot water pools in New Zealand the H_2S is dissolved but not compressed. HGP-A is a deep well under pressure, therefore it will have a greater dilution factor. Thus, there were no errors or inconsistencies in the reported H_2S levels.

Question 29:

"If areas in New Zealand tolerate and thrive with sulfur levels of 1000 ppb, why does U.S. EPA set our acceptable level at about 1/3 this amount?" (Parnell, Siegel, Thomas)

Response:

We assume that the drafter of this question is referring to hydrogen sulfide. There is no EPA standard for H_2S. There are few state standards for H_2S. The California standard is set at 30 ppb to alleviate the odor nuisance impacts of H_2S emissions and has no health implications. The lowest concentration which brings about health symptoms noticeable within hours is around 10,000 ppb (8 hr. average). This level is the OSHA standard. The proposed State of Hawaii maximum limit standards of 100 ppb is 100x below this level in order to protect even sensitive individuals from adverse health effects. As far as we know, the U.S. has no intention of setting H_2S air quality standards. The New Zealand health people both in Wellington and in Rotorua see no need.

Question 30:

"Why hasn't there been a health survey conducted for the Volcano community before geothermal development takes place?" (Anderson)

Response:

An Advisory Committee, appointed by the Director of Health, has recommended that further health surveys in the Volcano area at this time would be premature. More specifically, the Committee recommended health surveys in the Puna area not be undertaken until plans are finalized for developing geothermal resources in the Kahauale'a area. Before proceeding with a baseline health survey, it would be important to determine just where the wells will be drilled and which "community" (if any) would be most impacted by a change in air quality due to the development of geothermal resources in the area. The Committee further recommended that baseline air monitoring data should be collected before geothermal exploratory activities commence in any proposed development areas.

Question 31:

"What does the high rate of lung and respiratory distress in Puna compared with the rest of the state say about developing geothermal in the area? (i.e., it's already a high risk population)" (Anderson, Thomas)

Response:

The areas surveyed in Puna were found to have a relatively high rate of chronic bronchitis, hayfever (with or without asthma), sinusitis, and other respiratory system diseases when compared to Hawaii county and State-wide prevalence rates. Furthermore, individuals with predisposing chronic respiratory disease may be especially sensitive to H_2S, although there is no good evidence of increased susceptibility in the literature. It is also reasonable to presume that the aged and infants may also be at an increased risk of adverse health effects. However, it would be purely speculative to assume that the low levels of the H_2S measured in Puna near existing geothermal wells (averaging less than 10 ppb) could cause an exasperation of pre-existing chronic respiratory conditions. Interestingly, as a side note, individuals who had recently consumed alcohol have been found to be especially sensitive to H_2S.

High levels of SO_2 and particulates discharged during volcanic episodes have been associated with exacerbation of sympotoms among those with severe chronic respiratory conditions.

Question 32:

"Given the substantial amount of existing information on the biota of Puna, would you agree that the forest ecosystem of Kahauale'a is far better than that of the Puna Forest Reserve in terms of biological diversity, integrity and value?" (Lamoureux)

Response:

We cannot answer this question until the baseline study now underway is completed, since there is currently very little published information of any sort on the Puna Forest Reserve.

Question 33:

"If so, would you favor a land exchange to preserve Kahauale'a forests from development and allow geothermal development in the more biologically degraded Puna Forest Reserve? This concept has been suggested by the National Park Service." (Lamoureux)

Response:

If the baseline study confirms that Kahauale'a forests are more pristine than the Puna Forest Reserve, then the possibilities and feasibility of a land exchange should certainly be examined.

Question 34:

"Despite your disclaimers of no health problems associated with H_2S in New Zealand, if a Hawaii community does not want to be exposed to nose-detectable levels of H_2S, do you feel that their wishes should be pushed aside, even if for the "greater good" of Oahu's clean air?" (Miller, Siegel)

Response:

We believe most people would agree that the health question is of primary importance.

State and local studies are providing objective data on health and nuisance issues as they relate to geothermal emissions.

Question 35:

"What effect will the present clear-cutting of forest in lower Kahauale'a have on the rest of the ahupua'a's forests?" (Lamoureux)

Response:

The clear cut forests will obviously be destroyed. However, the forests seem to be separated from the rest of the forests in the ahupua'a of Kahaualea by recent lava flows and we are not sure there would be any direct effects on these forests. There might be effects on the forests in the Wao Kele o Puna Natural Area Reserve which do abut the forests now being cut.

Question 36:

"With high sulfur particles in the air in Volcano during eruptions, what does this mean for P.S.D. rules to be set up for governing industry's addition of sulfur into the air?" (Houck)

Response:

It probably will mean very little. Prevention of Significant Deterioration (PSD) regulations are pollutant specific. The volcano puts out lots of SO_2 virtually no H_2S and some particles. Geothermal emissions will put out some H_2S and no SO_2 (unless an H_2S incineration abatement system is used in which case geothermal will put out some SO_2). It will also put out very little in the way of particles. Whether or not the particles contain a high percentage of sulfur won't matter since the total particulate loading in the air is what is regulated under P.S.D. regulations. Even when the volcano erupts the particulate concentration in the air is low as compared to standards and industrialized mainland values.

Question 37:

"Would Class I rules — the strictest P.S.D. rules — be applied to geothermal development next to the National Park, a Class I area?" (Houck)

Response:

Yes.

Question 38:

"Do you consider yourself an expert in toxicology? If not, are your medical conclusions supported by a toxicologist?" (Siegel)

Response:

This question was directed specifically to Dr. Siegel. Sanford Siegel is a Botanist and Biochemist by professional training. He has specialized in research related to the environmental effects of geothermal emissions, especially lead, mercury, and hydrogen sulfide on organic systems including man. He does not necessarily consider himself an expert in toxicology despite his extensive background and professional experience in the biochemistry of toxic substances. The medical conclusions expressed in his New Zealand study were reviewed and corroborated by Frank Tabrah, M.D., professor of Family and Community Medicine, John A. Burns School of Medicine, U.H. Manoa; and Associate Medical Director, Straub Hospital.

Question 39:

"Conversely, isn't it true that you cannot rule out the possibility that H_2S is causing some of the respiratory problems experienced in Leilani Estates or other nearby areas?" (Anderson)

Response:

It is true that the design of the Puna Health study did not allow investigators to rule out the possiblity that H_2S is at least contributing to some of the respiratory problems in the Puna area. In fact, there may be certain individuals who are especially sensitive to H_2S (see Question 31).

Question 40:

"What are you (Environmental Issues Panel) paid to be on the commission? Can I get on the commission, too?" (Miller, Munger, O'Brien, Parnell)

Response:

State employees:
Travel expenses for state employees covered air and ground transportation and $45.00 per day for hotels and meals. Any expenses in excess of the $45.00/day were paid by the employee.

Private consulting firms:
Received the same travel compensation as state employees and also donated 2½ days of non-salaried time. "As the man said when he was tarred and feathered and carried out of town on a rail, 'If it weren't for the honor of it, I would rather have walked'."

Utility company representatives:
Travel and lodging expenses incurred by utility company representatives were paid for by the utility company.

Panel Participants:
Participants in the Environmental Issues panel are not members of a "commission" and we are not paid to be on the "commission." We are individuals selected by the State Department of Planning and Economic Development on the basis of our individual expertise and reputations for competence in our respective professional, scientific, or academic fields. Any individual with the required professional competence to carry out the necessary research is eligible for consideration. Civic interest and willingness to donate considerable personal time to the issues under study is a requirement for participation.